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SECURE IMAGE CONCEALMENT THROUGH PIXEL-LEVEL **STEGANOGRAPHIC EMBEDDING FOR CONFIDENTIAL DATA** PROTECTION

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ABSTRACT

Steganography plays a crucial role in modern information security systems by enabling the creation of concealed and secure communication channels between a sender and a receiver. This technique typically involves embedding a secret message within an image file. Recognizing the increasing need for secure communication, we propose a new algorithm designed to achieve the objectives of steganography effectively. This paper introduces a pixel-based image hiding method using steganography, where the pixels of a cover image serve as the medium for concealing secret text. The recipient can then apply a reverse extraction process to recover the original hidden message. The performance of this technique is evaluated using Peak Signal-to-Noise Ratio (PSNR) and capacity metrics. Experimental results demonstrate that our proposed method achieves higher data-hiding capacity compared to traditional approaches.

Keywords: Steganography, Information Security, Pixel-Based Image Hiding, PSNR, Data Capacity.

1. INTRODUCTION

With rapid advancement in Multimedia technologies during the recent years, communication and information exchange have become much easier and faster but at the same time the issues related to datasecurity and confidentiality have become amajor concern of the time. Protection of transmitted digital images against illegal accessing, copying, modification, and distribution plays a crucial role in securingimages transmissions over vulnerablenetworks [1]. Three basic security requirements must be met to have secured image transmission. These requirements are confidentiality, authenticity, and integrity. The confidentiality requirement means that only authorized users can have access to the image, whereas authenticity verifies the owner of the transmitted image. Any modifications made to the image can be detected by enforcing the integrity requirement. Both Steganography and cryptography are two integral parts of information security.

Cryptography is the study of algorithms of sending messages in encrypted form (not understood) so that only the authorized recipients can decrypt message and read it.Cryptography system is classified into symmetric-key system and asymmetric- key system [2]. Symmetric-key system uses a single key that both the sender and the receiver have, and asymmetric-key system uses two different keys (a public- key and a private-key), where the public key is known to everyone and the private key is known to only the authorized recipient of messages uses.

Steganography is the process of hiding data under the image. In this process critical data is hidden into another piece of data which seems to be normal. It is done to keep the attacker unaware of the actual data [3]. This is implemented to avoid dataleakage among unauthorized users of the system. The output is an image called stego-image that is similar to the cover media. This stego image is then sent to the receiver where the receiver retrieves thehidden message by applying the desteganography. A stego-key is used for embedding/encoding process to restrictdecoding or extraction of the embedded data in cover media. The modern age steganography is usually implemented computationally, where multimedia files are used as cover media.

A good Steganographic mehods has three features, good hiding capacity, good imperceptibility and the last is robustness. The digital image Steganographic methodsgenerally depends upon various image scrambling techniques in order to further improve the level of security of the hidden information. Image scrambling techniques scramble the pixels of an image in such a manner that the image becomes chaotic and indistinguishable. Hence, the message remains highly secured against unauthorised access.

Steganography can be split into two types, fragile and robust. In fragile steganography[4], information is embedded into a carrier called 'Cover' without being detected orretrieved by an attacker or unauthorized user. If the fragile data is modified then the secret data is destroyed as well without detection. On the other hand, robust steganography or sometimes known as digital watermarking aims to embed information into a cover while providing detection and protection capabilities if an attempt is made to destroy the cover.

Steganography techniques in the image can be divided into two categories, I) Steganography in the pixel domain (space

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domain), and II) in the transform domain such as frequency domain. In the case of pixel domain, the steganography operation is directly performed on the pixels. In transform domain steganography, themessage embedding is performed in transformed image. The image istransformed from the space domain into a new domain such as frequency domain. This transforming can be done with different transforms such as Fourier andWavelet transform. In our proposed system we have developed an algorithm which will be useful for pixel based data hiding and which satisfies the characteristics of steganography.

Remaining paper is organized as follows, Section introduces the Literature survey.

Section III presents described methodology. Section IV describes the results and finally paper concludes with Section V.

2. LITERATURE SURVEY

Mohit Gupta, Praveen Kr. Tripathi et. al. [5], explained the steganography techniqueusing BLINDHIDE algorithm along with its implementation and application. They proposed and implemented a method which hides secret data in color images by maintaining good visual quality and takes very less time in hiding and extraction of message. This method is based on thirdlevel two-dimensional discrete wavelettransform set by Haar wavelet. The main advantage is that there is no requirement oforiginal image in extraction process which makes secret communication undetected by third party user or any steg analysistools. They used Huffman coding for better imperceptibility result secret image. They used MATLAB R2014a for experimental activities.

Ankit Gambhir, Sibaram Khara, et. al. [6], explained the process that provides multilayer security by integrating cryptography with steganography. Fist they considered the message and performed the RSA encryption which resulted in a cipher text. They later hided the cipher text in audio using LSB audio steganography algorithm. Similarly, at receiver's end, first cipher text is extracted from the audio cover then it is decrypted into message by using RSA decryption which combines both the features of steganography and cryptography and provides a higher level of security.

Qu and H. J. Kim, et. al. [7] presents Pixel-based pixel value ordering predictor for high-fidelity reversible data hiding. This technique combined sorting, prediction-error expansion and histogramshifting. Instead of scanning in a block-byblock manner, it predicted pixel in a pixel- by-pixel manner. In this way, pixel was

scanned in raster order and determined to be the current pixel. Other pixels in the same block of a rectangular region, onevertex of which is the current pixel are the context pixels. Obviously, this predictor provides more probability for obtaining prediction value than the aforementioned three category predictors. Holub, Vojtěch, Jessica Fridrich, and Tomáš Denemark, et. al. [8], the author defines a universal distortion function called universal waveletrelative distortion (UNIWARD) forsteganography in the frequency space. The distortion is considered as the form of a sum of relative changes between the cover and embedded images that is represented in the transform domain and, it is computed in the wavelet domain as a sum of relative changes of coefficients in a directional filter bank decomposition of the cover image.

Rosziati Ibrahim, Teoh Suk Kuan, et. al. [9], explained an algorithm to hide dataunder image which uses binary codes and pixels inside an image. They used zipped file before it is converted to binary codesto maximize the storage of data inside the image. They developed a system called steganography imaging system which is then tested to see the viability of the proposed algorithm. Images stores various sizes of data and the Peak Signal-to-Noise Ratio (PSNR) is also captured for each of the images tested. Based on the PSNR value of each images, they stated that the stego image has a higher PSNR value.

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[10] describes Expansion embedding techniques for reversible watermarking. This new technique was combined with histogram shifting to embed data as an effective method. It well exploits the correlation inherent of the neighborhood pixels. The current pixel located on the block boundary. Context pixels cannot encircle the current pixel. Hence, only the preceding or subsequent partial pixels are effective for prediction. This type is categorized to be half-enclosing prediction.

PIXEL-BASED IMAGE HIDINGUSING STEGANOGRAPHY

This section describes Pixel based Image Hiding using Steganography. We have taken a text file which contains the secret text and an image file which will be act as cover image to hide the data. The process of image-based steganography is very simple. Images are composed of pixels which describes the content of image. Pixels are usually made up of colors. Every pixel is of combination of three colors red, green and blue. We kept the sole aim of maintaining the characteristics of image file.

Embedding Process: The process of embedding is performed in following steps:

a. Select a text file which contains the secret text.

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b. Select a cover image file of size M x N pixels. Create a sequence of pixels starting from 0,0 and so on and generate number of iterations for these sequences of pixels.

c. Find the length of characters of the secret message.

d. Run the loop for length of characters.

(1) Firstly, the character is converted into 8-bit binary format using ASCII values.

(2) Take first three set of pixels to encode. Each set has three values of red, green and blue each. So, there are total nine values. We have eight bits of the secret message character. So, if each color can be modified slightly, by setting the LSB to zero or one, these three pixels can store a byte with one value of color is left.

- (3) Taking the color values from left toright, change the pixel to even for 0 and odd for 1.
- (4) Previous step gives the new set of pixels. Save it.

(5) Continue the process for each character.

- e. Replace the new set of pixels with set of original cover image pixels.
- f. Here is the secret message is embeddedunder the cover image.

Now, save the generated cover image. To share this cover image with authenticated user, use any secure way of data sharingby keeping in view that image should not be compressed or its dimension must notbe changed. The best way of securely data sharing without losing its original dimension is email service butadministrator can use any of the sharing medium.

Save the byte of data in byte array,

iv. Continue the process until the last bit of the last color of the last pixel that you read is 1.

c. Create the data set by collecting data from byte array.

d. Reveal the data to the user.



Fig. 1: EMBEDDING PROCESS

Extraction Process: For the data to be



Fig. 2: EXTRACTING PROCESS

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Based on the bits values in the embedded message, the pixel bits may be changed (increased or decreased). In the receiverside, the Extraction Process will be applied to the image, then the image pixels values are used together to retrieve the embedded message.

3. RESULT ANALYSIS

In this section, performance evaluation of the proposed method is performed on the collection of some famous images using two standard criteria of steganography.

extracted at the user side, we need the steganograted image file which is sharedby the administrator. We also need the algorithm which is used for embedding thedata under the cover image.

The process of extraction is performed as following.

- a. Select the steganograted image.
- b. Generate the sequences of pixels.
- i. Run the loop for sequences of pixels.

ii. Consider the first three set of pixels from left to right.

iii. Extract the data byte from the set ofpixels by left shifting the pixels.

Examples of the images are shown in Fig

3. Following are the parameters derived oncomparing the steganograted imagegenerated by our proposed method with steganograted image generated by BlindHide steganography algorithm. Peak signal to noise ratio (PSNR) and Capacity areused parameters.

Peak Signal to Noise Ratio (PSNR) expresses the similarity between the imagebefore and after the steganography. The stego image should be similar to the original (cover) image and their PSNR iscalculated using below formula: B²

 $PSNR = 10. \log_{10} (MSE) \dots (1)$

M N 1

 $MSE(i_1, i_2) =$



Fig. 3: PSNR ANALYSIS

```
\sum \sum [i_1(x, y) - \underline{i_2(x, y)}]^2 \dots (2)
NM
x=1 y=1
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Where, B is the maximum fluctuation in the input image.



Fig. 4: SAMPLES OF COVER IMAGES

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Steganography capacity: Thesteganography capacity expresses theamount of data that can be hidden per pixeland is calculated in bits per pixel unit. In order to evaluate this criterion, the maximum amount of the message bits that can be embedded in the image, with different compression quality, arecalculated and their mean is considered as capacity.

Comparative analysis of Pixel based ImageHiding using Steganography (PIH-S) with steganograted image generated by BlindHide steganography (BH-S) algorithm isrepresented in below Table 1.

Table 1: COMPARATIVE ANALYSIS

Method used	PSNR	Capacity (considered for fox image)
PIH-S	65	57615 bits
BH-S	54	56942 bits





Fig. 5: CAPACITY ANALYSIS

The result indicates that the Pixel basedImage Hiding using Steganographymethod keeps high performance than Blind Hide steganography (BH-S) algorithm while increasing the embedded message volume.

4. CONCLUSION

This paper discusses a pixel-based image hiding technique using steganography. The primary objective of steganography is to establish a secure and confidential communication channel between the sender and receiver. The embedding process follows a predefined replacement table, where pixel values are adjusted (either increased or decreased) based on the bit values of the hidden message. To assess the effectiveness of the proposed method, Peak Signal-to-Noise Ratio (PSNR) and the maximum data-hiding capacity are used as evaluation criteria. The results indicate that our approach can embed a larger volume of secret data while maintaining a stego image quality that closely resembles the original image.

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